UNIVERSITI PUTRA MALAYSIA

NITROGEN USE EFFICIENCY OF RICE CROP AS INFLUENCED BY PLANTING METHODS UNDE R GLASSHOUSE CONDITION

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It is hereby certified that we have read this thesis entitled 'The Nitrogen Use Efficiency of Rice as Influenced by Planting Methods Under Glasshouse Conditions' by Muhamad bin Harun, and in our opinion it is satisfactory in terms of scope, quality and presentation as partial fulfilment of the requirements for the degree of Master of Agricultural Science

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NITROGEN USE EFFICIENCY OF RICE CROP AS INFLUENCED BY PLANTING METHODS UNDER GLASSHOUSE CONDITION

by

Muhamad Bin Harun

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The response of nitrogen from the direct seeded rice in terms of yield increase and fertilizer use efficiency were studied under controlled glasshouse experiment. This was done to determine the effect of direct seeding technique on nitrogen fertilizer use efficiency as compared to the traditional transplanting method. In this study the soil used was obtained from the abandoned rice land located at Balik Pulau where a pilot project of rehabilitation of idle padi land using the technique of direct seeding was also concurrently under trial in the field.

The results obtained indicated that direct seeding technique was more responsive to nitrogen fertilizer at high level of applied nitrogen (120 kg/ha). The nitrogen uptake, dry matter production and grain yield was high in direct seeded rice as compared to transplanted rice.

The grain yield of direct seeded rice showed an increment of 14% when the applied nitrogen level was increased from 80 to 120 kg/ha. However, there was no different in grain yield of transplanted rice under similar conditions. Response to nitrogen from 0 to 120 kg/ha on the dry matter production was double for the direct seeded rice when compared to that of the transplanted rice. It also followed that nitrogen uptake of direct seeded rice was found to be greater than the transplanted rice at all levels of nitrogen applied. However, the efficiency of nitrogen usage was unable to be determined due to low range of fertilizer nitrogen used in the present experiment. This could be done by using higher levels of nitrogen (> 120 kg/ha) since there was further response at 120 kg/ha.

Abstrak tesis yang diserahkan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari syarat yang diperlukan untuk mendapatkan Ijazah Master Sains Pertanian.

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Kesan nitrogen terhadap tanaman padi tabur terus dari segi pertambahan hasil dan kecekapan guna baja telah dikaji di dalam percubaan terkawal di rumah kaca. Kajian ini dibuat untuk menentukan kesan teknik tabur terus ke atas kecekapan kegunaan baja nitrogen dibandingkan dengan kaedah mengubah cara tradisional. Di dalam kajian ini tanah yang digunakan adalah diambil dari kawasan tanah terbiar di Balik Pulau di mana satu projek perintis pemulihan tanah sawah terbiar dengan menggunakan teknik tabur terus sedang diuji di peringkat ladang.

Keputusan-keputusan yang diperolehi menunjukkan bahawa teknik tabur terus memberi kesan yang lebih terhadap baja nitrogen pada kadar pemberian nitrogen yang tinggi (120 kg/ha). Pengambilan nitrogen, pengeluaran bahan kering dan hasil padi didapati tinggi bagi padi yang ditabur terus jika dibandingkan dengan padi cara mengubah.

Hasil padi tabur terus menunjukkan pertambahan 14% apabila kadar nitrogen yang digunakan bertambah dari 80 ke 120 kg/ha. Akan tetapi, tidak terdapat perbezaan hasil bagi padi cara mengubah di dalam keadaan yang sama. Kesan nitrogen dari 0 ke 120 kg/ha ke atas pengeluaran bahan kering adalah dua kali ganda bagi padi tabur terus apabila dibandingkan dengan tanaman cara mengubah. Begitu juga didapati bahawa pengambilan nitrogen bagi padi tabur terus adalab lebih besar dari padi cara mengubah di semua kadar nitrogen yang diberi. Dalam percubaan ini kecekapan kegunaan nitrogen tidak dapat ditentukan kerana kadar nitrogen yang digunakan adalah rendah. Ini boleh diatasi dengan menggunakan kadar-kadar nitrogen yang lebih tinggi (> 120 kg/ha) memandangkan terdapat kesan lanjut pada kadar 120 kg/ha.

CHAPTER 1

INTRODUCTION

In Peninsular Malaysia the direct seeding of rice (*Oryza sativa* L) crop is becoming popular in major rice growing areas since early eighties. In the Muda Agricultural Development Authority (MADA) alone, direct seeding started in 1977 for an area of about nine hectares and increased to about 750 hectares by 1980. From then on, it increased rapidly to about 18,500 hectares by 1982 (Ho, 1982). Other major areas where direct seeding is practised are Tanjong Karang (1,700 hectares) and Seberang Perak (450 hectares).

The high cost of unreliable labour to do manual transplanting and the time constraints to establish the crop for planting season are main reasons for the farmers to accept the direct seeding technique which has been practised in Thailand. MADA statistics indicated that wage for transplanting had increased over the last decade. The labour cost for transplanting was around $20.00 per acre in 1970, but increased to $45.67 per acre in the main season of 1975, and by the off season of 1981, it was $80.80 per acre. For these periods, the

increase in wages was 128% and 308% respectively, which accounted for a very large input on the production cost per unit area for transplanting alone. Besides this, the availability of hired labour is also uncertain, particularly at peak periods during the months of February and March for off season, and September and October for the main season.

The problem of water supply which is not always available at the right time severely affects the nursery management. This is an additional factor which leads to late transplanting and hence the double cropping season is always affected. These, among several socio-economic factors, lead to large track of padi lands been left idle throughout the country (Table I).

The direct seeding method can become a labour saving alternative and the shorter crop cycle will save time and hence it will overcome the problem of delay planting. The other advantage is that a small investment is required because once the land is levelled the uptake of nutrient and plant growth could be uniform, leading to high efficiency in management of the crop. Furthermore, direct seeding method can strive to the high yield potential easier than the transplanting method and it is easier to mechanise. Hand broad-casting can be replaced by a simple tractor-drawn seeder, which is being practised by some farmers in the Tanjong Karang area in Selangor.

TABLE I

SUMMARY OF CULTIVATED AND ABANDONED PADI LAND THROUGHOUT PENINSULAR MALAYSIA (HECTARES)

State	Area of Padi Land	Main Season Crop	Off Season Crop	Abandoned Area in Off Season	Abandoned Area Throughout	Abandoned Area in Off Season and Throughout the Year
Perlis	11,827	11,827	1,120	10,707	-	10,707
Kedah	19,915	18,190	1,468	16,722	1,724	18,447
P. Pinang	1,535	483	57	426	1,052	1,478
Perak	7,320	5,041	1,031	4,010	2,280	6,290
Selangor	1,005	477	51	425	529	954
N. Sembilan	7,809	3,047	240	2,807	4,763	7,570
Melaka	11,116	7,282	728	6,554	3,833	10,387
Johore	3,850	1,138	329	809	2,712	3,520
Pahang	24,696	12,907	126	128	11,788	24,569
Trengganu	36,266	26,185	5,754	20,432	10,080	30,512
Kelantan	45,664	36,734	6,339	30,403	8,930	39,333
TOTAL	171,001	123,310	17,234	106,076	47,691	153,767

(Source: Laporan Pembangunan Tanah-Tanah Terbiar, Kementerian Pertanian Malaysia - 1980)

Although it is gaining popularity, the practise cannot be fully successful unless several field problems such as adequate land levelling for efficient water management and modified but appropriate agronomic practices such as weed control and fertilizer programmes are overcome. These, perhaps, could be achieved through collaborative large scale field experimentation in areas with large potential for development. To-date, part of this is now undertaken at Bt. Chawi, Hilir Perak, together with a private company. (Shamsuddin, per.comm. 1984).

Field investigation by Sugimoto and Ho (1981) revealed that continuous practice of direct seeding in the same area caused the depletion of the inherent soil fertility, resulting in obvious nitrogen and phosphorus deficiency symptoms. This is because possibly the increase in planting density is not accompanied by a corresponding increase in fertilizer application, the soil in the direct seeded field is generally not flooded after ploughing, the ammonium generated during the decomposition of the organic matter will be converted into nitrate under oxidised condition on the soil surface. Hence, nitrogen will be lost in the form of gas upon subsequent flooding through the process of denitrification, the absence of ammorphos (11% N: 48% $P_2 O_5$) application in direct seeding method as compared to the transplanting method lead to deficiency of phosphorous and nitrogen. These are some of the main

reasons cited for the deficiences of the two major nutrients noted.

Fertilizer particularly that of nitrogen problem in direct seeding method arises because of the unavailability of fertilizer recommendation for direct seeding rice. The farmers as well as the Agricultural Officers are not certain whether the recommended fertilizer rates for the normal transplanted rice is also applicable for the direct seeded rice. In the absence of this, it is assumed that the rate and time of fertilizer for direct seeded rice is the same as transplanting method. This may not be the case for direct seeded rice because of its larger plant population and that the plants stay longer in the main-field as compared to the transplanted rice. This has lead to Siow and Salehuddin (1982) to re-evaluate the fertilizer recommendation for direct seeded crop for the Tanjong Karang area in Selangor. To date no such information is available.

With some of these in view, a short term study to evaluate the overall influence of the two planting methods on the efficiency of fertilizer nitrogen ranging from zero to 120 kg/ha was conducted using soil obtained from an abandoned rice land from Balik Pulau where a rehabilitation trial using direct seeding technique outlined by a Thai rice expert (Prachern, 1982) was concurrently being tried out under actual field situation. The influence of the common rates of

fertilizer nitrogen (0 to 120 kg/ha) in term of yield was evaluated under the traditional manual transplanting and the new direct seeding method.

CHAPTER 2

LITERATURE REVIEW

Planting Methods

Generally rice can be produced either by transplanting or direct seeding methods. The main difference between the two methods is that in the former method, seedlings are first raised in the seedbed or nursery before they are transplanted in the main field. In direct seeding, the seed is sawn directly in the main field either by hand broadcasting or row seeding or drilling with a suitable machine.

The manual transplanting method is the common method in many rice producing countries including Malaysia. The transplanting method is also the traditional method in Asia, while the direct seeding method is practised in Australia and the United States on large, commercial scale. Direct seeded rice can be established mechanically or manually in the dry, puddled or flooded conditions. The common practice of direct seeding is broadcasting either manually or mechanically; it can be spread out evenly or drilled in lines.

There are several advantages of direct seeding technique over the transplanting method. First of all it is a labour saving device which requires 35.5 man-days less than the transplanting method per hectare. Shaaban (1975) showed that direct seeding method required 76.5 man-days per hectare while the transplanting method required 112 man-days per hectare (Table II). Nursery preparation and transplanting operations constituted 44% of the total man-day requirement in the transplanting method. Moreover the direct seeding method can reduce the duration of this part of crop cycle by about 10 to 14 days.

Further this technique has the potential for obtaining high yield from high panicle number per unit area in combination with the appropriate panicle size. From the basic concept that by growing one seed to get only one large, healthy panicle which has an average of one hundred grains, and using seed rate of 100 kg per hectare, mathematically, one hectare of padi can produce up to ten tons of grains. In Thailand, farmers using this technique have been known to achieve production level between six to seven tons per hectare per season (Prachern, 1983).

Additional profit margin can be achieved by this technique. Apart from initial land preparations, the technique cuts the input cost particularly transplanting and increasing the grain yield. It can also be modified so as to make rice production partially or completely